Dish Engine Critical Components (DECC) Project

SES System - Proven Technology

- Over 25,000 hours of on-sun operating time
- Over 250 MWh on-sun generated energy
- Over 125,000 hours of chemical fuel operation
- 24.9 kW Peak Power
- 29.4% Peak Efficiency
- 95% Availability

DECC Project - Overview

- **Phase I & II Objectives**
  - **Phase I**
    - Operate Existing Systems
    - Measure Reliability & Performance Data
  - **Phase II**
    - Build 2 Completely New Systems
    - Operate Multiple Systems
    - Measure Reliability & Performance Data
    - Develop Manufacturing & Suppliers for HVM
    - Develop Marketing & Business Plan for Commercialization
- **Schedule**
  - Phase I = 4/98 to 8/99; Phase II = 10/99 to 12/02

DECC & Other Solar Business Funding Commitments By SES

- **DECC Program (Both Phases)**
  - ∞ Total Projected Costs = $ 8.0 Million
    - ✓ DOE Contracts = $ 3.2 Million (40%)
      ($2.5 Mil Paid To Date)
    - ✓ SES (Remainder)= $ 4.8 Million (60%)

- **Total Expenditures To Date By SES**
  - ∞ Non-DECC = $ 7.2 Million
  - ∞ DECC
    - ✓ Phase I = $ 0.4 Million ($ 444,000)
    - ✓ Phase II = $ 1.1 Million ($1,103,000)
  - ∞ Total SES To Date = $ 8.7 Million

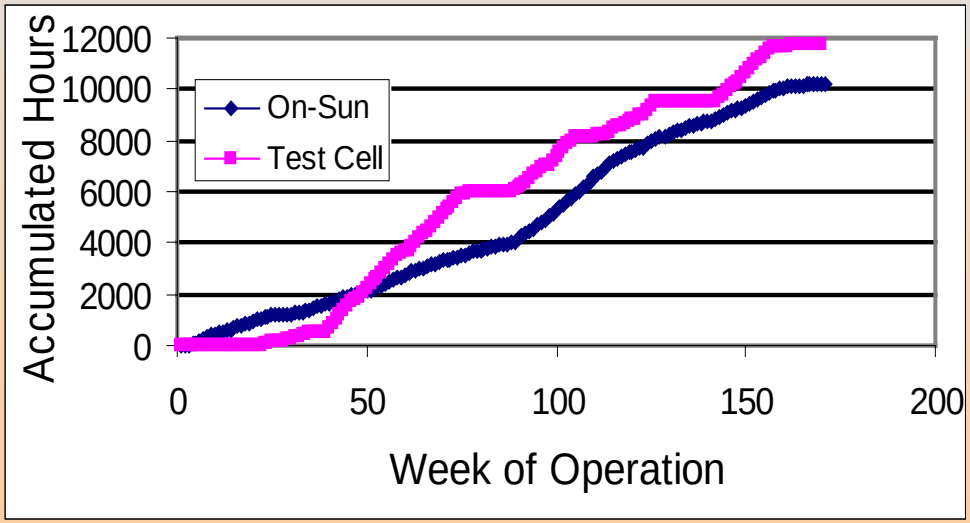
- **Total Spent & Committed To Date $12.0 Million**

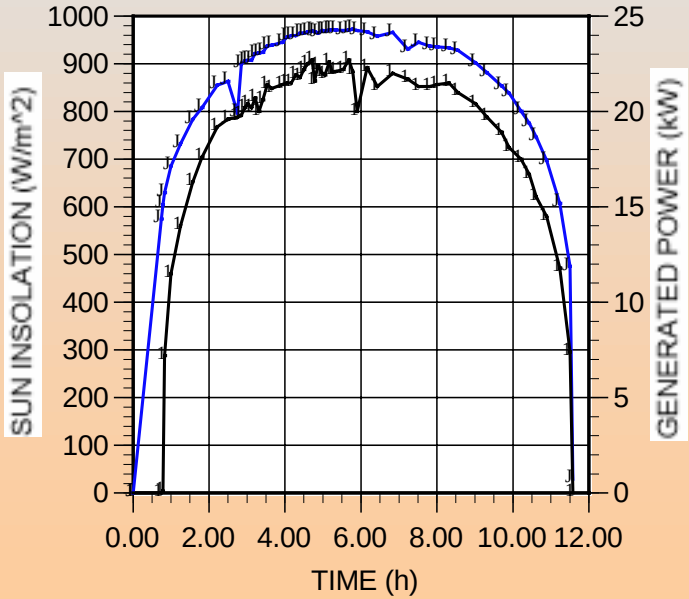
DECC Project - Accomplishments

- **Phase I:**
  - Refurbished 1 Concentrator & 2 PCUs
  - Operation, Maintenance & Reliability Data Collected
  - Successfully Completed, On-Schedule & On-Budget
- **Phase II:**
  - Refurbished 2nd Concentrator & 2 Additional PCUs
  - Operation, Maintenance & Reliability Data Collection Continues
  - Successfully Transferred to UNLV
  - UNLV Students Operating System & Collecting Data

DECC - Demonstrated Power

- **Power**
  - Peak Net Power = 24.9 kWe
  - Over 10,000 hrs On-Sun Operation
    - Phase I = 3,500 hours
    - Phase II = 7,000 hours to-date & still going strong!
  - Nearly 12,000 hrs Test Cell Operation

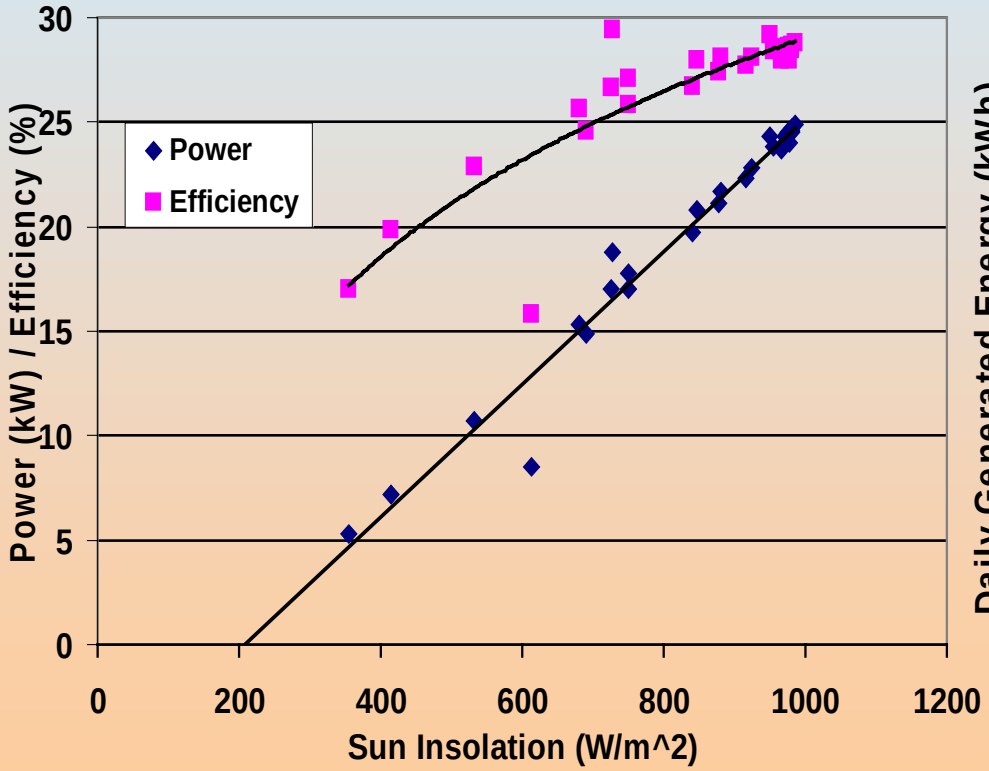


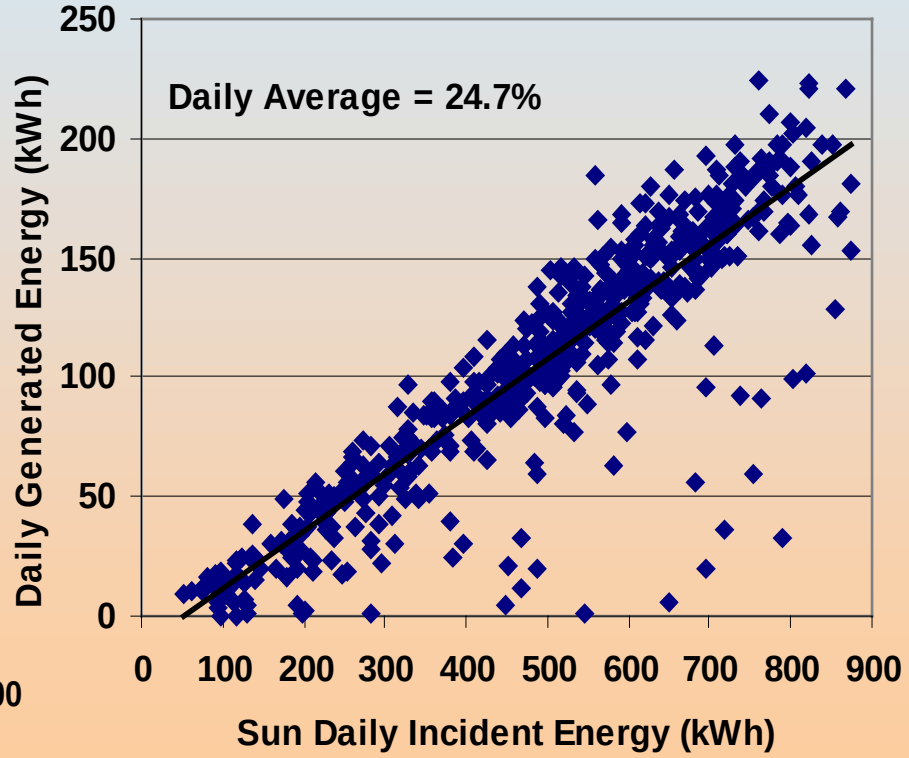


Over 10,000 Hours Successful On-Sun Operation

DECC - Demonstrated Efficiency

- **Efficiency**
  - ∞ Peak = 28.9%, Daily Avg. (net) = 24.7%

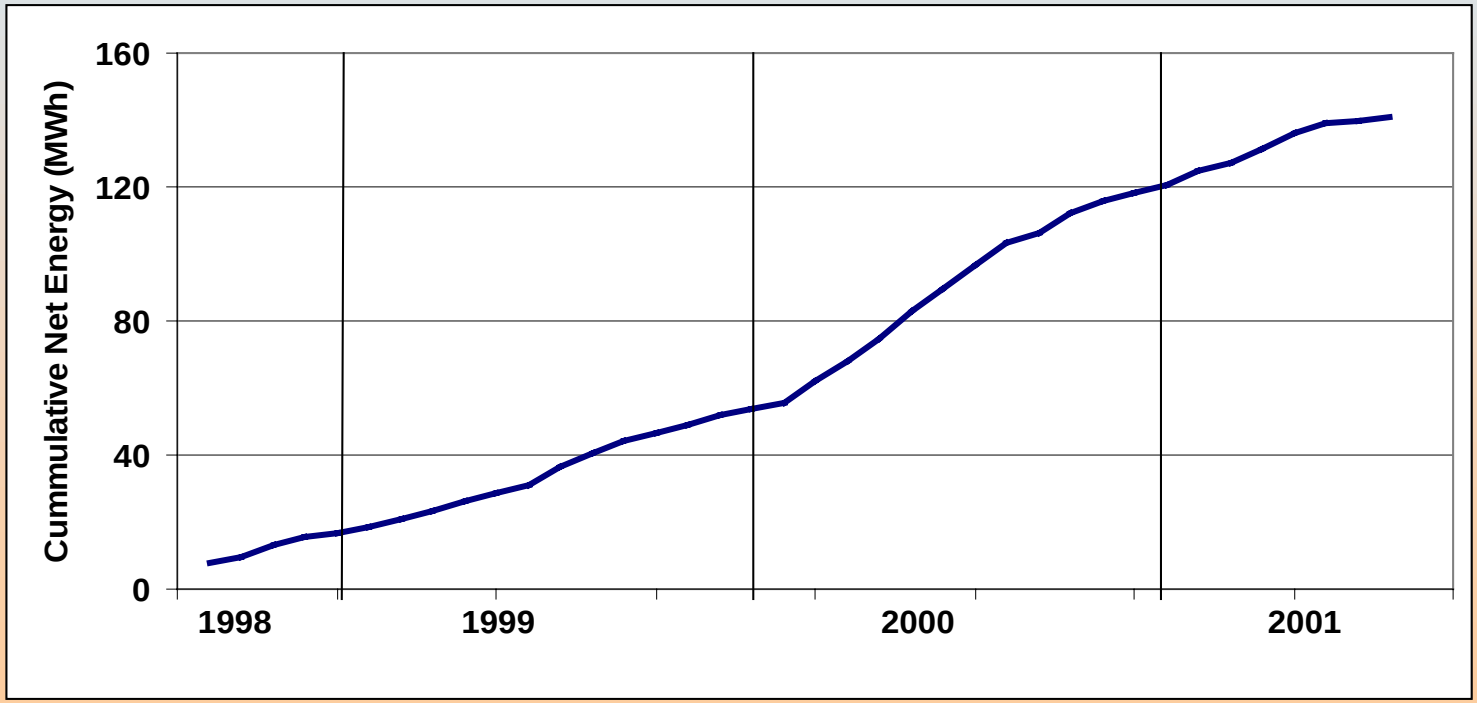




SES Solar Technology Holds World Record (29.4%) for Sun-to-Electricity Efficiency

DECC - Demonstrated Energy

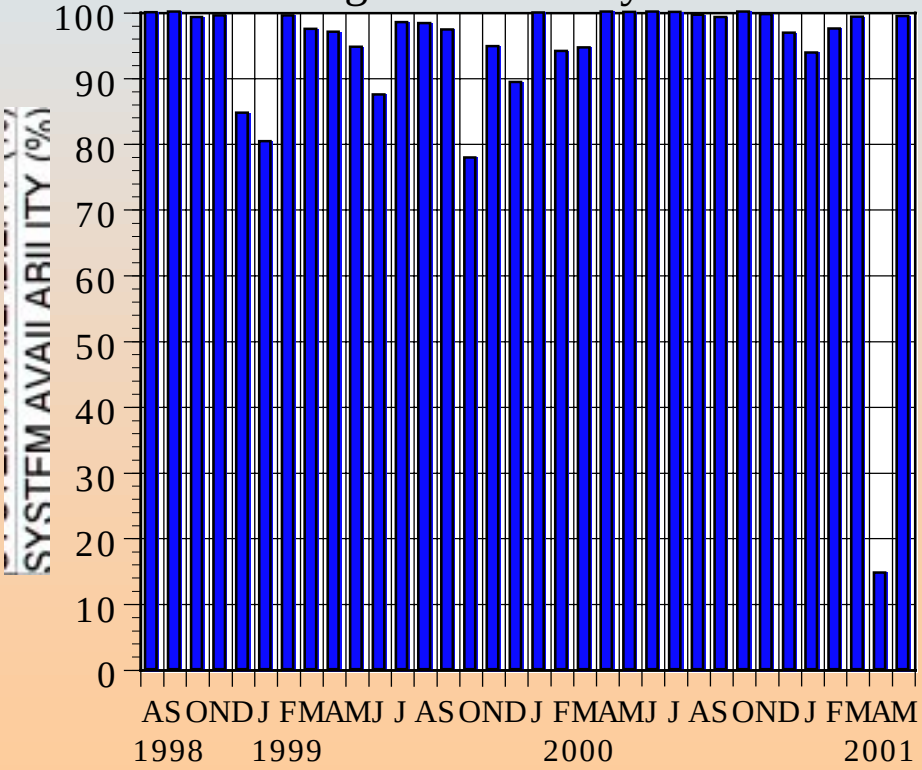
- **Energy Generation**
  - ∞ Over 140 MWh on-sun operation
    - ✷ Phase I = 42 MWh
    - ✷ Phase II = 100 MWh to-date and still going strong!

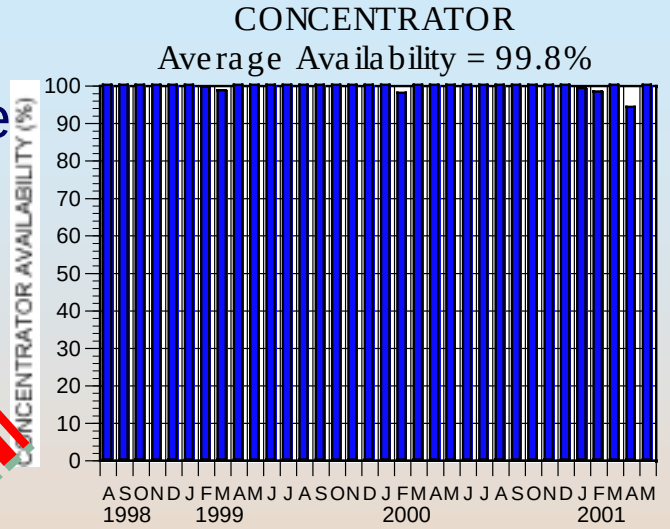


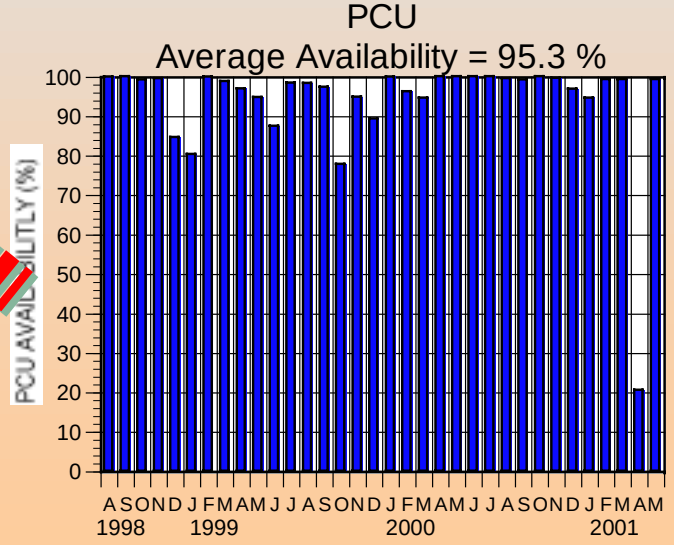
Over 140 MWh On-Sun Energy Produced

DECC - Demonstrated Availability

- **Availability**
  - ∞ On-sun over 95% of available time
    - ✷ Phase I = 94%; Phase II = 96%



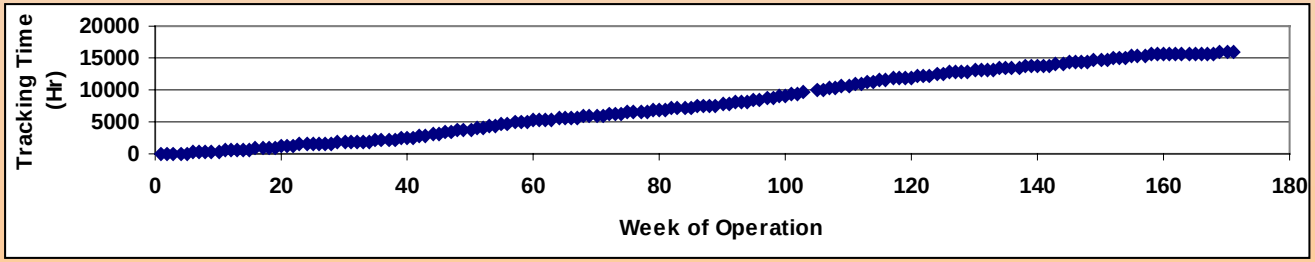




Over 95% Availability with Prototype Hardware

DECC - Demonstrated Life/Reliability

- **PCU Life/Reliability (to date)**
  - PCU 206 = 3,143 hrs, continuing
    - 1,900+ hrs on original seals
    - 1,200+ hrs on new seals, still testing
  - PCU 209 = 3,848 hrs, continuing
    - 3,848 hrs on original seals, still testing
  - PCU 212 = 9,655 hrs, continuing
    - 7,400+ hrs on original seals
    - 2,200+ hrs on new seals, still testing
  - PCU 213 = 5,531 hrs, continuing
    - 5,531 hrs on original seals, still testing
- **Concentrator Reliability**
  - Over 16,000 Tracking Hours, testing continues



17+ year Old Hardware Operating Like New

DECC - Manufacturing/Producibility

- **Modular Design**
- **Readily Adapted To High Volume Manufacturing**
- **“Funny Shaped Car”**
- **Qualifying Suppliers**
  - ∞ Engine - Identified/Qualified
  - ∞ Mirror Module - Identified
  - ∞ Structures & Controls - In-Process

DECC - Manufacturing/Producibility

■ Readily Adapted to High Volume Manufacturing

COMPONENT REQUIREMENTS FOR VARIOUS-SIZED SOLAR SYSTEM VOLUMES			
Rated Capacity	**30 kW**	**30 MW**	**300 MW**
No. Of 30 kW Systems	1	1,000	10,000
No. of Components:			
Sq. Meters of Glass	99	99,235	992,350
Azimuth/Elev. Drive Motors (ea.)	1	1,000	10,000
Lbs. Of Structural Steel	7,500	7,500,000	75,000,000
Inconel Tubing (Lin. Ft.)	144	144,000	1,440,000
Piston Assemblies	4	4,000	40,000
Crankshafts	2	2,000	20,000
Gas Coolers, Regenerators (ea.)	8	8,000	80,000
Engine Blocks, Radiators, Generators (ea.)	1	1,000	10,000

DECC Program - Accomplishments

- **Currently Testing**
  - Key Next Generation PCU Hardware
    - Heater heads, regenerators, gas coolers, piston assys, bearings, connecting rods, compressor, aperture cone, sensors, etc.
  - 1st Articles Completed
  - Over 1000 hrs of On-Sun Testing & Continuing!
- **Currently Manufacturing**
  - Remaining PCU Hardware
    - Engine blocks, cylinder blocks, crankcase, covers, etc.
  - 1st Articles in-process
- **Manufacturing Next Generation Dish Hardware**
  - Mirror modules, actuators, fast slew system, etc.
  - Long-lead parts & tooling in-process

Next Steps...

- **Complete DECC Phase II**
  - 2 Completely New Systems
    - 2 New Concentrators, 5 New PCUs
    - New Qualified Suppliers
    - Increase rated power to 28.5 kWe
    - Increase efficiency by 5%
  - Expand Lab Support By Siting 1 System at Sandia
- **Nevada Project**
  - 1 MW Plant, 40 Systems
- **Demo & Small Projects**
  - US & International
- **Commercial Deployment**
  - Grid Connected (Mid & Large Sizes)
  - Small Remote & Grid Connected
  - Distributed

SES Solar Stirling System

- **Demonstrated Performance**
- **Holds world record for most efficient solar electric generation (17+ years)**
- **Mass producible/cost competitive**
  - ∞ Automotive style manufacturing
  - ∞ High volume/low cost
- **DECC Program continues…**
  - ∞ Outstanding performance
  - ∞ Durable Product
- **Winning Technology!!**
  - ∞ Grid Connected (Mid & Large Sizes)
  - ∞ Small Remote/Off-Grid
  - ∞ Distributed